

AMENDMENTS TO THE CLAIMS

Claims 1-25 (cancelled).

26. (currently amended) An electromagnetic rotary actuator, controlled by a single voltage, comprising:

a rotor movable about an axis and including at least one permanent magnet having magnet poles;

a stator having at least one winding; and

an airgap formed between facing surfaces of the at least one permanent magnet and of the stator,

wherein the at least one permanent magnet is arranged to have flux lines extending in the airgap substantially in a radial direction from or towards the axis;

wherein the stator has at least three pole teeth made of a magnetically permeable material, the at least one winding applied around a central one of the at least three pole teeth, and the at least three pole teeth having end surfaces forming the facing surfaces of the stator and thus facing surfaces of the at least one permanent magnet over the airgap; and

wherein the magnet poles of the at least one permanent magnet of the rotor and the at least three pole teeth all have the same angular pitch, the angle, taken from the axis, between any two of said at least three pole teeth is substantially an integer multiple

~~of the angular pitch of the magnet poles of the at least one permanent magnet of the rotor and~~

wherein the rotor has a peak to peak movement that is substantially less than 360 degrees about the axis.

27. (previously presented) The electromagnetic rotary actuator of claim 26, wherein the end surfaces of the at least three pole teeth are located close to the facing surfaces of the at least one permanent magnet creating an airgap smaller than 0.5 mm.

28. (previously presented) The electromagnetic rotary actuator of claim 26, wherein the end surfaces of the at least three pole teeth are located close to the facing surfaces of the at least one permanent magnet creating an airgap smaller than 0.3 mm.

29. (previously presented) The electromagnetic rotary actuator of claim 26, wherein

at least three pole teeth have windings;
all of said windings are connected to one single voltage source;
and

said at least three pole teeth having windings are centrally located.

30. (previously presented) The electromagnetic rotary actuator of

claim 29, wherein said at least three pole teeth having windings are located around a central pole tooth.

31. (previously presented) The electromagnetic rotary actuator of claim 26,

wherein the stator comprises exactly three pole teeth; and wherein the exactly three pole teeth are arranged within an angle, taken from the axis, of at most somewhat more than a third of a full turn.

32. (previously presented) The electromagnetic rotary actuator of claim 31, wherein the exactly three pole teeth are arranged within an angle smaller than 130° .

33. (previously presented) The electromagnetic rotary actuator of claim 26,

wherein the stator comprises exactly five pole teeth; and wherein the exactly five pole teeth are arranged within an angle, taken from the axis, of at most somewhat more than half a full turn.

34. (previously presented) The electromagnetic rotary actuator of claim 33, wherein the exactly five pole teeth are arranged within an angle smaller than 225° .

35. (cancelled)

36. (previously presented) The electromagnetic rotary actuator of claim 26, wherein the at least three pole teeth and/or the at least one permanent magnet are/is so arranged that by activating the at least one winding the rotor can move with a peak to peak movement only within a limited angular range about the axis.

37. (previously presented) The electromagnetic rotary actuator of claim 36, wherein a maximum of the limited angular range is substantially 25° .

38. (previously presented) The electromagnetic rotary actuator of claim 36, wherein the rotor has a maximum movement of at most substantially $\pm 12.5^\circ$ from a central position of the rotor.

39. (previously presented) The electromagnetic rotary actuator of claim 36, wherein the airgap has a shape substantially corresponding to part of a cylindrical shell.

40. (previously presented) The electromagnetic rotary actuator of to claim 36, wherein an angular sector extending between the two outermost ends of those portions of the at least three pole teeth that face the air gap is longer than the sum of the peak to peak

movement of the rotor and an angular sector extending between the two outermost ends of the magnet poles of the at least one permanent magnet of the rotor facing the air gap.

41. (previously presented) The electromagnetic rotary actuator of claim 36, wherein an angular sector extending between the two outermost ends of those portions of the at least three pole teeth that face the air gap is substantially equal to the sum of the peak to peak movement of the rotor and an angular sector extending between the two outermost ends of the magnet poles of the at least one permanent magnet of the rotor facing the air gap.

42. (previously presented) The electromagnetic rotary actuator of claim 36, wherein an angular sector extending between the two ends of one of the at least three pole teeth that face the air gap is longer than the sum of the peak to peak movement of the rotor and an angular sector extending between an end of a part of one of the at least one permanent magnet of the rotor facing the air gap and the nearest end of an adjacent one of the at least one permanent magnet of the rotor facing the air gap.

43. (previously presented) The electromagnetic rotary actuator of claim 26, wherein a normally cylindrical surface angular sector of a part of at least one of the at least three pole teeth facing the

magnet poles of the at least one permanent magnet over the air gap has a shape adapted to reduce the cogging torque of the electromagnetic rotary actuator.

44. (previously presented) The electromagnetic rotary actuator of claim 26, wherein the surfaces of those two outmost pole teeth of the at least three pole teeth that face the magnet poles of the at least one permanent magnet over the air gap have a shape adapted to reduce the cogging torque of the electromagnetic rotary actuator.

45. (previously presented) The electromagnetic rotary actuator of claim 26, wherein each of the at least three pole teeth that have said at least one winding has a reduced height in the axial direction at places of the pole tooth where said at least one winding is located, thereby permitting a portion of said pole tooth located at the airgap and at a radially inner surface of said pole tooth to be longer in an axial direction than a portion of said pole tooth located axially inside the at least one winding applied to said pole tooth.

46. (previously presented) The electromagnetic rotary actuator of claim 26, further comprising an electronic driver circuit connected to said at least one winding, said electronic driver circuit including a resistance changer to increase a resistance connected in

series with said at least one winding when a longer electric time constant is advantageous or required and to reduce the resistance in series with said at least one winding when a short electric time constant is advantageous or required.

47. (previously presented) The electromagnetic rotary actuator of claim 26,

wherein the at least one winding is applied as individual coils around central ones of the at least three pole teeth; and
wherein all the coils of the at least one winding are connected to receive the same electrical phase.

48. (previously presented) The electromagnetic rotary actuator of claim 26, wherein the at least one permanent magnet has a number of magnet poles along its periphery that is one less than the number of pole teeth.

49. (previously presented) The electromagnetic rotary actuator of claim 26, wherein the angle between adjacent magnet poles of the at least one permanent magnet is larger than the maximum of the displacement of the rotor from a center position of the rotor.

50. (previously presented) The electromagnetic rotary actuator of claim 26, wherein the at least three pole teeth include only one

wound pole tooth and only two unwound pole teeth.

51. (previously presented) The electromagnetic rotary actuator of claim 26, wherein the at least three pole teeth include only three wound pole teeth and no unwound pole tooth.

52. (previously presented) The electromagnetic rotary actuator of claim 26, wherein the at least three pole teeth include only three wound pole teeth and only two unwound pole teeth.

53. (previously presented) The electromagnetic rotary actuator of claim 26, wherein the at least three pole teeth include only five wound pole teeth and no unwound pole tooth.

54. (previously presented) The electromagnetic rotary actuator of claim 26, wherein the at least three pole teeth have web portions projecting towards the rotor, the web portions having at their ends facing the rotor triangular peripheral projections, the free edges of the triangular peripheral projections located close to each other for adjacent ones of the at least three pole teeth.

55. (currently amended) The electromagnetic rotary actuator of claim [[51]] 54, wherein the gaps between the free edges of the triangular peripheral projections located close to each other for adjacent ones

of the at least three pole teeth have widths allowing that a coil of the at least one winding can be inserted through the gaps to be positioned around a pole tooth.

56. (previously presented) An electromagnetic rotary actuator, controlled by a single voltage, comprising:

a rotor movable about an axis and including at least one permanent magnet having magnet poles;

a stator having at least one winding; and

an airgap formed between facing surfaces of the at least one permanent magnet and of the stator,

wherein the at least one permanent magnet is arranged to have flux lines extending in the airgap substantially in a radial direction from or towards the axis;

wherein the stator has at least three pole teeth made of a magnetically permeable material, the at least one winding applied around a central one of the at least three pole teeth, and the pole teeth having end surfaces forming the facing surfaces of the stator and thus facing surfaces of the at least one permanent magnet over the airgap; and

wherein the end surfaces of the pole teeth are located close to the facing surfaces of the at least one permanent magnet creating an airgap smaller than 0.3 mm.

57. (previously presented) The electromagnetic rotary actuator of claim 56, wherein

at least three pole teeth have windings;

all of said windings are connected to one single voltage source;

and

said at least three pole teeth having windings are centrally located.

58. (previously presented) The electromagnetic rotary actuator of claim 56, wherein said at least three pole teeth having windings are located around a central pole tooth.

59. (previously presented) The electromagnetic rotary actuator of claim 56, wherein the magnet poles of the at least one permanent magnet of the rotor and the at least three pole teeth all have the same angular pitch.

60. (previously presented) The electromagnetic rotary actuator of claim 56, wherein the at least three pole teeth and/or the at least one permanent magnet are/is so arranged that by activating the at least one winding the rotor can move with a peak to peak movement only within a limited angular range about the axis.

61. (previously presented) The electromagnetic rotary actuator of

claim 60, wherein a maximum of the limited angular range is substantially 25°.

62. (previously presented) The electromagnetic rotary actuator of claim 56, wherein a normally cylindrical surface angular sector of a part of at least one of the at least three pole teeth facing the magnet poles of the at least one permanent magnet over the air gap has a shape adapted to reduce the cogging torque of the electromagnetic rotary actuator.

63. (previously presented) The electromagnetic rotary actuator of claim 56, wherein the surfaces of those two outmost pole teeth of the at least three pole teeth that face the magnet poles of the at least one permanent magnet over the air gap have a shape adapted to reduce the cogging torque of the electromagnetic rotary actuator.

64. (previously presented) The electromagnetic rotary actuator of claim 57, wherein each of the at least three pole teeth that have said at least one winding has a reduced height in the axial direction at places of the pole tooth where said at least one winding is located, thereby permitting a portion of said pole tooth located at the airgap and at a radially inner surface of said pole tooth to be longer in an axial direction than a portion of said pole tooth located axially inside the at least one winding applied to

said pole tooth.

65. (previously presented) The electromagnetic rotary actuator of claim 56,

wherein the at least one winding is applied as individual coils around central ones of the at least three pole teeth; and

wherein all the coils of the at least one winding are connected to receive the same electrical phase.

66. (previously presented) The electromagnetic rotary actuator of claim 56, wherein the at least three pole teeth include only one wound pole tooth and only two unwound pole teeth.

67. (previously presented) The electromagnetic rotary actuator of claim 56, wherein the at least three pole teeth include only three wound pole teeth and no unwound pole tooth.

68. (previously presented) The electromagnetic rotary actuator of claim 56, wherein the at least three pole teeth include only three wound pole teeth and only two unwound pole teeth.

69. (previously presented) The electromagnetic rotary actuator of claim 56, wherein the at least three pole teeth include only five wound pole teeth and no unwound pole tooth.

70. (previously presented) An electromagnetic rotary actuator, controlled by a single voltage, comprising:

a rotor movable about an axis and including at least one permanent magnet having magnet poles;

a stator having at least one winding; and

an airgap formed between facing surfaces of the at least one permanent magnet and of the stator,

wherein the at least one permanent magnet is arranged to have flux lines extending in the airgap substantially in a radial direction from or towards the axis;

wherein the stator comprises exactly three pole teeth made of a magnetically permeable material, the at least one winding applied around a central one of the exactly three pole teeth, and the exactly three pole teeth having end surfaces forming the facing surfaces of the stator and thus facing surfaces of the at least one permanent magnet over the airgap; and

wherein the exactly three pole teeth are arranged within an angle, taken from the axis, of at most somewhat more than a third of a full turn.

71. (previously presented) The electromagnetic rotary actuator of claim 70, wherein the exactly three pole teeth are arranged within an angle smaller than 130°.

72. (previously presented) The electromagnetic rotary actuator of claim 70, wherein the magnet poles of the at least one permanent magnet of the rotor and the exactly least three pole teeth all have the same angular pitch.

73. (previously presented) The electromagnetic rotary actuator of claim 70, wherein the exactly three pole teeth and/or the at least one permanent magnet are/is so arranged that by activating the at least one winding the rotor can move with a peak to peak movement only within a limited angular range about the axis.

74. (previously presented) The electromagnetic rotary actuator of claim 70,

wherein the at least one winding is applied as individual coils around central ones of the exactly three pole teeth; and

wherein all the coils of the at least one winding are connected to receive the same electrical phase.

75. (previously presented) The electromagnetic rotary actuator of claim 70, wherein the at least one permanent magnet has exactly two magnet poles along its periphery.

76. (previously presented) The electromagnetic rotary actuator of claim 70, wherein the exactly three pole teeth include one wound

pole tooth and two unwound pole teeth.

77. (previously presented) An electromagnetic rotary actuator, controlled by a single voltage, comprising:

a rotor movable about an axis and including at least one permanent magnet having magnet poles;

a stator having at least one winding; and

an airgap formed between facing surfaces of the at least one permanent magnet and of the stator,

wherein the at least one permanent magnet is arranged to have flux lines extending in the airgap substantially in a radial direction from or towards the axis;

wherein the stator comprises exactly five pole teeth made of a magnetically permeable material, the at least one winding applied around a central one of the exactly five pole teeth, the exactly five pole teeth having end surfaces forming the facing surfaces of the stator and thus facing surfaces of the at least one permanent magnet over the airgap; and

wherein the exactly five pole teeth are arranged within an angle, taken from the axis, of at most somewhat more than half a full turn.

78. (previously presented) The electromagnetic rotary actuator of claim 77, wherein the exactly five pole teeth are arranged within an

angle smaller than 225°.

79. (previously presented) The electromagnetic rotary actuator of claim 77, wherein the magnet poles of the at least one permanent magnet of the rotor and the exactly least five pole teeth all have the same angular pitch.

80. (previously presented) The electromagnetic rotary actuator of claim 77, wherein the exactly five pole teeth and/or the at least one permanent magnet are/is so arranged that by activating the at least one winding the rotor can move with a peak to peak movement only within a limited angular range about the axis.

81. (previously presented) The electromagnetic rotary actuator of claim 77,

wherein the at least one winding is applied as individual coils around central ones of the exactly five pole teeth; and

wherein all the coils of the at least one winding are connected to receive the same electrical phase.

82. (previously presented) The electromagnetic rotary actuator of claim 77, wherein the at least one permanent magnet has exactly four magnet poles along its periphery.

83. (previously presented) The electromagnetic rotary actuator of claim 77, wherein the exactly five pole teeth include three wound pole teeth and two unwound pole teeth.

84. (previously presented) An electromagnetic rotary actuator, controlled by a single voltage, comprising:

a rotor movable about an axis and including at least one permanent magnet having magnet poles;

a stator having at least one winding; and

an airgap formed between facing surfaces of the at least one permanent magnet and of the stator,

wherein the at least one permanent magnet is arranged to have flux lines extending in the airgap substantially in a radial direction from or towards the axis;

wherein the stator has at least three pole teeth made of a magnetically permeable material, the at least one winding applied around a central one of the at least three pole teeth, and the pole teeth having end surfaces forming the facing surfaces of the stator and thus facing surfaces of the at least one permanent magnet over the airgap; and

wherein the stator includes a substantial opening, in a circumferential plane, such that a portion of the rotor is exposed in the circumferential plane.

85. (previously presented) The electromagnetic rotary actuator of claim 84, wherein

at least three pole teeth have windings included in the at least one winding;

all of said windings are connected to one single voltage source; and

said at least three pole teeth having windings are centrally located.

86. (previously presented) The electromagnetic rotary actuator of claim 84,

wherein the at least one winding is applied as individual coils around central ones of the at least three pole teeth; and

wherein all the coils of the at least one winding are connected to receive the same electrical phase.

87. (previously presented) The electromagnetic rotary actuator of claim 84, wherein the angle between adjacent magnet poles of the at least one permanent magnet is larger than the maximum of the displacement of the rotor from a center position of the rotor.

88. (previously presented) An electromagnetic rotary actuator, controlled by a single voltage, comprising:

a rotor movable about an axis and including having at least one

permanent magnet having magnet poles;
a stator having at least one winding; and
an airgap formed between facing surfaces of the at least one permanent magnet and of the stator,
wherein the at least one permanent magnet is arranged to have flux lines extending in the airgap substantially in a radial direction from or towards the axis;
wherein the stator has at least three pole teeth made of a magnetically permeable material, the at least three pole teeth having end surfaces forming the facing surfaces of the stator and thus facing surfaces of the at least one permanent magnet over the airgap;
wherein the at least one winding is applied as individual coils around central ones of the at least three pole teeth; and
wherein all the coils of the at least one winding are connected to receive the same electrical phase.

89. (previously presented) The electromagnetic rotary actuator of to claim 88, wherein all end terminals of the coils are connected to each other.

90. (previously presented) The electromagnetic rotary actuator of to claim 88, wherein all the coils are connected in series with each other.

91. (previously presented) The electromagnetic rotary actuator of claim 88, wherein the end surfaces of the at least three pole teeth are located close to the facing surfaces of the at least one permanent magnet creating an airgap smaller than 0.5 mm.

92. (previously presented) The electromagnetic rotary actuator of claim 88, wherein the end surfaces of the at least three pole teeth are located close to the facing surfaces of the at least one permanent magnet creating an airgap smaller than 0.3 mm.

93. (previously presented) The electromagnetic rotary actuator of claim 88, wherein

at least three pole teeth have windings;

all of said windings are connected to one single voltage source;
and

said at least three pole teeth having windings are centrally located.

94. (previously presented) The electromagnetic rotary actuator of claim 93, wherein said at least three pole teeth having windings are located around a central pole tooth.

95. (previously presented) The electromagnetic rotary actuator of claim 88, wherein the magnet poles of the at least one permanent

magnet of the rotor and the at least three pole teeth all have the same angular pitch.

96. (previously presented) The electromagnetic rotary actuator of claim 88, wherein the at least three pole teeth and/or the at least one permanent magnet are/is so arranged that by activating the at least one winding the rotor can move with a peak to peak movement only within a limited angular range about the axis.

97. (previously presented) The electromagnetic rotary actuator of claim 96, wherein a maximum of the limited angular range is substantially 25°.

98. (previously presented) The electromagnetic rotary actuator of claim 96, wherein the rotor has a maximum movement of at most substantially $\pm 12.5^\circ$ from a central position of the rotor.

99. (previously presented) The electromagnetic rotary actuator of claim 96, wherein the airgap has a shape substantially corresponding to part of a cylindrical shell.

100. (previously presented) The electromagnetic rotary actuator of to claim 96, wherein an angular sector extending between the two outermost ends of those portions of the at least three pole teeth

that face the air gap is longer than the sum of the peak to peak movement of the rotor and an angular sector extending between the two outermost ends of the magnet poles of the at least one permanent magnet of the rotor facing the air gap.

101. (previously presented) The electromagnetic rotary actuator of claim 96, wherein an angular sector extending between the two outermost ends of those portions of the at least three pole teeth that face the air gap is substantially equal to the sum of the peak to peak movement of the rotor and an angular sector extending between the two outermost ends of the magnet poles of the at least one permanent magnet of the rotor facing the air gap.

102. (previously presented) The electromagnetic rotary actuator of claim 96, wherein an angular sector extending between the two ends of one of the at least three pole teeth that face the air gap is longer than the sum of the peak to peak movement of the rotor and an angular sector extending between an end of a part of one of the at least one permanent magnet of the rotor facing the air gap and the nearest end of an adjacent one of the at least one permanent magnet of the rotor facing the air gap.

103. (previously presented) The electromagnetic rotary actuator of claim 88, wherein a normally cylindrical surface angular sector of a

part of at least one of the at least three pole teeth facing the magnet poles of the at least one permanent magnet over the air gap has a shape adapted to reduce the cogging torque of the electromagnetic rotary actuator.

104. (previously presented) The electromagnetic rotary actuator of claim 88, wherein the surfaces of those two outmost pole teeth of the at least three pole teeth that face the magnet poles of the at least one permanent magnet over the air gap have a shape adapted to reduce the cogging torque of the electromagnetic rotary actuator.

105. (previously presented) The electromagnetic rotary actuator of claim 88, wherein each of the at least three pole teeth that have said at least one winding has a reduced height in the axial direction at places of the pole tooth where said at least one winding is located, thereby permitting a portion of said pole tooth located at the airgap and at a radially inner surface of said pole tooth to be longer in an axial direction than a portion of said pole tooth located axially inside the at least one winding applied to said pole tooth.

106. (previously presented) The electromagnetic rotary actuator of claim 88, further comprising an electronic driver circuit connected to said at least one winding, said electronic driver circuit

including a resistance changer to increase a resistance connected in series with said at least one winding when a longer electric time constant is advantageous or required and to reduce the resistance in series with said at least one winding when a short electric time constant is advantageous or required.

107. (previously presented) The electromagnetic rotary actuator of claim 88, wherein the at least one permanent magnet has a number of magnet poles along its periphery that is one less than the number of pole teeth.

108. (previously presented) The electromagnetic rotary actuator of claim 88, wherein the angle between adjacent magnet poles of the at least one permanent magnet is larger than the maximum of the displacement of the rotor from a center position of the rotor.

109. (previously presented) The electromagnetic rotary actuator of claim 88, wherein the at least three pole teeth include only one wound pole tooth and only two unwound pole teeth.

110. (previously presented) The electromagnetic rotary actuator of claim 88, wherein the at least three pole teeth include only three wound pole teeth and no unwound pole tooth.

111. (previously presented) The electromagnetic rotary actuator of claim 88, wherein the at least three pole teeth include only three wound pole teeth and only two unwound pole teeth.

112. (previously presented) The electromagnetic rotary actuator of claim 88, wherein the at least three pole teeth include only five wound pole teeth and no unwound pole tooth.

113. (previously presented) The electromagnetic rotary actuator of claim 88, wherein the at least three pole teeth have web portions projecting towards the rotor, the web portions having at their ends facing the rotor triangular peripheral projections, the free edges of the triangular peripheral projections located close to each other for adjacent ones of the at least three pole teeth.

114. (previously presented) The electromagnetic rotary actuator of claim 113, wherein the gaps between the free edges of the triangular peripheral projections located close to each other for adjacent ones of the at least three pole teeth have widths allowing that a coil of the at least one winding can be inserted through the gaps to be positioned around a pole tooth.

115. (previously presented) An electromagnetic rotary actuator, controlled by a single voltage, comprising:

a rotor movable about an axis and including at least one permanent magnet having magnet poles;

a stator having at least one winding; and

an airgap formed between facing surfaces of the at least one permanent magnet and of the stator,

wherein the at least one permanent magnet is arranged to have flux lines extending in the airgap substantially in a radial direction from or towards the axis;

wherein the stator has at least three pole teeth made of a magnetically permeable material, the at least one winding applied around a central one of the at least three pole teeth, and the at least three pole teeth having end surfaces forming the facing surfaces of the stator and thus facing surfaces of the at least one permanent magnet over the airgap; and

wherein the at least three pole teeth and the magnet poles of the at least one permanent magnet are so arranged that when the rotor is in a position in which the center of one of the magnet poles faces the center of a gap between two adjacent ones of the at least three pole teeth, the center of at least one of the two adjacent magnet poles faces the center of the gap between two adjacent ones of the at least three pole teeth.

116. (previously presented) The electromagnetic rotary actuator of claim 115, wherein the at least three pole teeth and/or the at least

one permanent magnet are/is so arranged that by activating the at least one winding the rotor can move with a peak to peak movement only within a limited angular range about the axis.

117. (previously presented) The electromagnetic rotary actuator of claim 115, wherein the at least one permanent magnet has a number of magnet poles along its periphery that is one less than the number of pole teeth.

118. (previously presented) The electromagnetic rotary actuator of claim 115, wherein the angle between adjacent magnet poles of the at least one permanent magnet is larger than the maximum of the displacement of the rotor from a center position of the rotor.

119. (previously presented) An electronic circuit for driving a single phase rotary actuator, the electronic circuit connectable to a winding or windings of the single phase rotary actuator, wherein a resistance changer increases a resistance in series with the winding or windings when a longer electric time constant is advantageous or required and to reduce the resistance in series with the winding or windings when a shorter electric time constant is advantageous or required.

120. (previously presented) The electronic circuit of claim 119,

wherein the resistance changer comprises:

a first bridge leg directly connectable to a terminal of the winding or windings; and

a second bridge leg connectable through a resistor to the same terminal of the winding or windings.

121. (previously presented) The electronic circuit of claim 119, wherein the resistance changer varies the impedance of a resistor having a controllable resistance.

122. (previously presented) The electronic circuit of claim 119, wherein the resistor having a controllable resistance is a MOSFET.